CURRENT STATUS OF CUTTHROAT TROUT SUBSPECIES IN THE WESTERN BONNEVILLE BASIN

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ABSTRACT.— Recent discoveries of native cutthroat trout populations in desert mountain ranges on the western fringe of the Bonneville Basin have prompted intensified management efforts by state and federal agencies. Analysis of Snake Valley cutthroat specimens in Trout Creek, Deep Creek Mountain Range, Utah, indicate this is a pure strain of the trout which once inhabited Pleistocene Lake Bonneville and which was thought to be extinct in Utah. The Snake Valley cutthroat is similar to *Salmo clarki utah* of the eastern Bonneville Basin; however, electrophoretic and morphomeristic analysis show unique genetic differences brought about by long-term isolation (8,000 years) from the remainder of the Bonneville Basin cutthroat. This cutthroat is a common ancestor to several other limited cutthroat populations within the basin in Nevada. In May 1977 the BLM withdrew from mineral entry about 27,000 acres within the Deep Creek Mountains for protection of this salmonid cutthroat and other unique resources on the range. Results of 1977 stream surveys on the Pilot Peak Mountain Range, Utah, indicate the presence of the threatened Lahontan cutthroat, *Salmo clarki henshawi,* in one isolated stream.

The ancient Pleistocene Lake Bonneville in the Great Basin once supported a cutthroat trout, native to the Snake Valley area of Utah-Nevada, which abounded in the area's several streams upon the lake's decline (Hickman 1977). Because of deteriorating habitat the cutthroat population rapidly diminished in the twentieth century to a point where it was believed to be extinct within its native range (Behnke 1976a) (Fig. 1).

In 1953 Ted Frantz, Nevada Fish and Game Department, discovered a cutthroat trout population in Pine Creek on Mt. Wheeler, Nevada (Frantz and King 1958). Samples were sent to Dr. Robert Miller, who indicated they represented pure cutthroat trout. But Dr. Miller was unable to assign them to any described subspecies (letter from Dr. Miller to F. Dodge, 26 May 1971). Though it was assumed this cutthroat was introduced from Trout Creek drainage of the Snake Valley area (Miller and Alcorn 1946), this seems unlikely when one considers that there were streams closer to Pine Creek which probably contained cutthroat trout (Lehman, Baker, Snake, and Hendrys creeks). Behnke (1976a) indicates the most logical origin of the Pine Creek cutthroat was from Lehman Creek (Mt. Wheeler tributary of the Snake Valley region) via the Osceola Ditch, constructed as a pioneer waterway.

During 1953 the Nevada Fish and Game Department introduced 44 fish from Pine Creek into Hampton Creek, Nevada. A second transplant of 54 cutthroat from Pine Creek was made into Goshute Creek, Nevada, in 1960. The Nevada Fish and Game Department, assuming these were Utah cutthroat, *Salmo clarki utah,* closed these streams to fishing and listed *S.c. utah* as an endangered species in Nevada. Mr. Frank Dodge, Nevada Fish and Game Department, in 1972 found a population of cutthroat trout in the headwaters of Hendrys Creek (Mt. Moriah tributary of the Snake Valley region) which resembled those found in Pine Creek. Following this, several unsuccessful attempts were made by the Nevada Fish and Game Department to locate additional pure populations of cutthroat trout in the Snake Valley area of Utah and Nevada.

In 1973 the BLM (Utah) began stream habitat surveys in the Deep Creek Moun-

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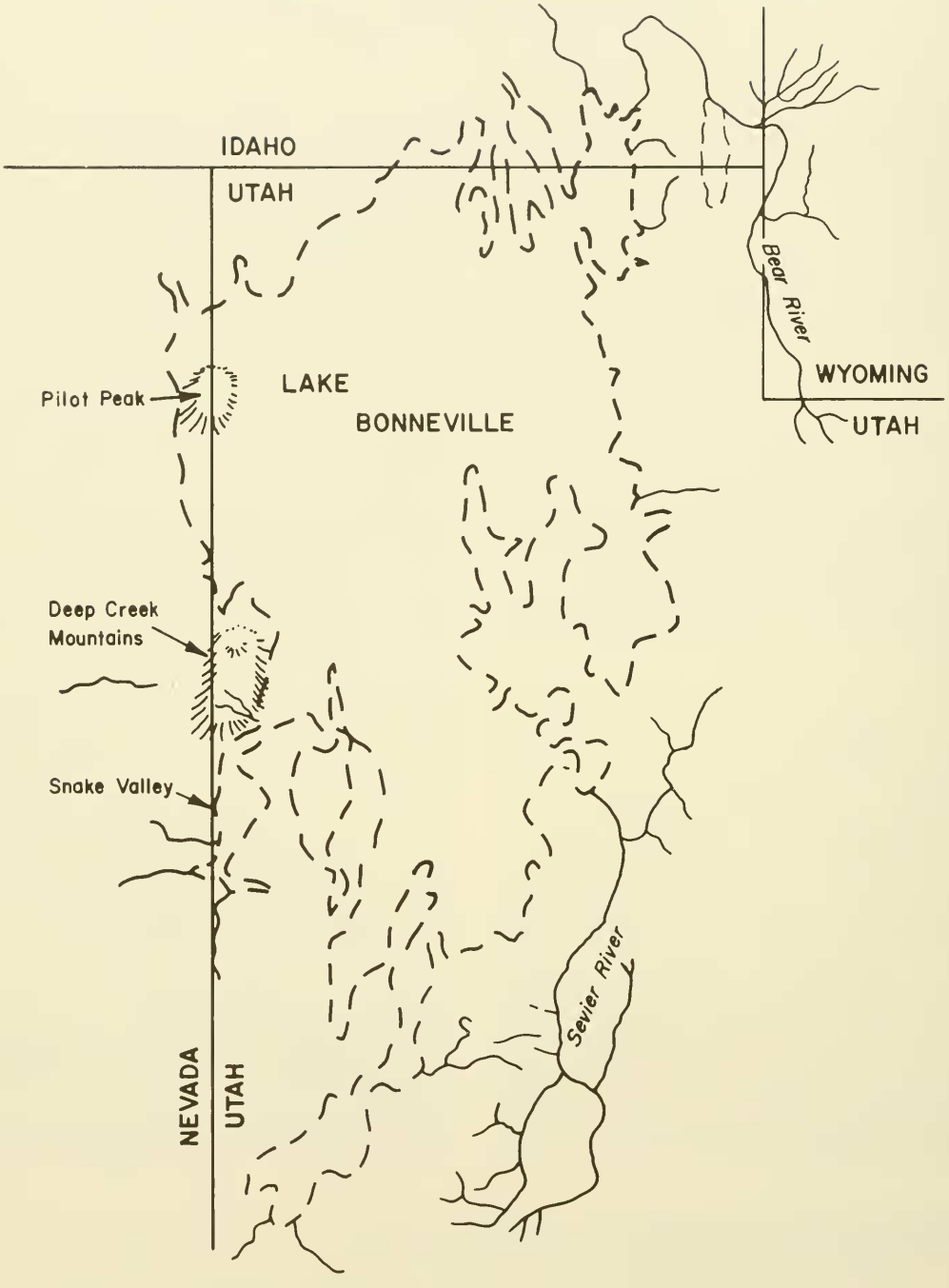

Fig 1. Area map location showing the western Bonneville Basin area.

tain Range in an attempt to define critical habitats and possible remnant populations of the cutthroat. In the spring of 1974, BLM biologists Don Duff and Josh Warburton discovered cutthroat in the extreme headwaters of Trout Creek, Utah, above a natural barrier falls. Subsequent sampling and analysis by the BLM, Utah Division of Wildlife Resources and Colorado State University (under contract funded by BLM) determined that Trout Creek specimens were pure strain fish of the Bonneville Basin. Inventories have continued to date, and the only stream found to contain a pure population was Trout Creek. Hybridized populations (with rainbow trout) were found in Birch Creek and Johnson Creek (Hickman 1977) (Fig. 2).

Reasons for Decline

When the Snake Valley arm of Lake Bonneville dried up, there were relatively few perennial streams in the area. In addition to this, since the mid 1800s, introductions of nonnative trouts, climatic conditions, irrigation practices, and habitat loss and degradation have been influential in reducing the number of cutthroat populations in the Snake Valley area. Replacement and hybridization from introductions of exotic rainbow trout (*Salmo gairdneri*) have posed the most significant impact to the survival of the Snake Valley cutthroat. Virtually every stream in the Snake Valley region capable of supporting trout has been stocked with rainbows. Brook trout are also capable of replacing the cutthroat through competition because of earlier spawning periods and its ability to become better adapted to life in small spring-fed headwater streams.

Exploitation, though not likely a limiting factor by itself, can reduce the number of catchables and may act to favor other exotics such as the brooks, browns, and hybrids. It has been documented that cutthroat trout are highly vulnerable to angling mortality (Behnke and Zarn 1976).

Livestock grazing imposes a subtle but serious threat to the survival of the cutthroat trout in the arid Snake Valley region. Grazing becomes significant when discussing sites for reintroductions, because much of the prime grasslands exist in headwater meadow areas. Livestock interests in the Bonneville Basin have been unconcerned about stream protection of rare trout populations. These problems have made the BLM very cautious in planning for additional habitat sites for future reintroductions of the Snake Valley cutthroat. Many studies have shown that livestock grazing destroys and degrades riparian vegetation and streambank soil stability, resulting in alterations of channel morphology, loss of cover, and a reduction in numbers and biomass of fish—particularly older and larger trout (Behnke 1977). Studies and management of livestock-impacted areas should be made in order to rehabilitate the grazed areas, either through improvement of the existing grazing system or livestock exclusion (Platts 1977). The BLM in Utah and Nevada has been involved in streamside fencing programs to protect the riparian habitat of streams containing sensitive or rare trout populations from continued livestock damage (Goshute Creek, Nevada, and Birch Creek, near Beaver, Utah).

Droughts and violent thunderstorms may have historically eliminated cutthroat populations from some high gradient streams, because natural recolonization could not be effective after desiccation of the pluvial lake in Snake Valley. This may account for the high number of barren streams found in the Snake Valley region prior to rainbow trout introductions.

Past surface disturbance impacts from mining have been slight and of short duration, the main damage resulting from equipment movement and road construction to and from the mine site. There exists little room for trails or roads in some of the narrow canyons; therefore, the streambed may be utilized for such purposes in some areas. Recent uranium mining activities in Utah's Deep Creek Mountains have caused concern over the future impacts of mining to the resources of this fragile desert island ecosystem environment.

The effects of all these environmental impacts on the cutthroat trout populations are

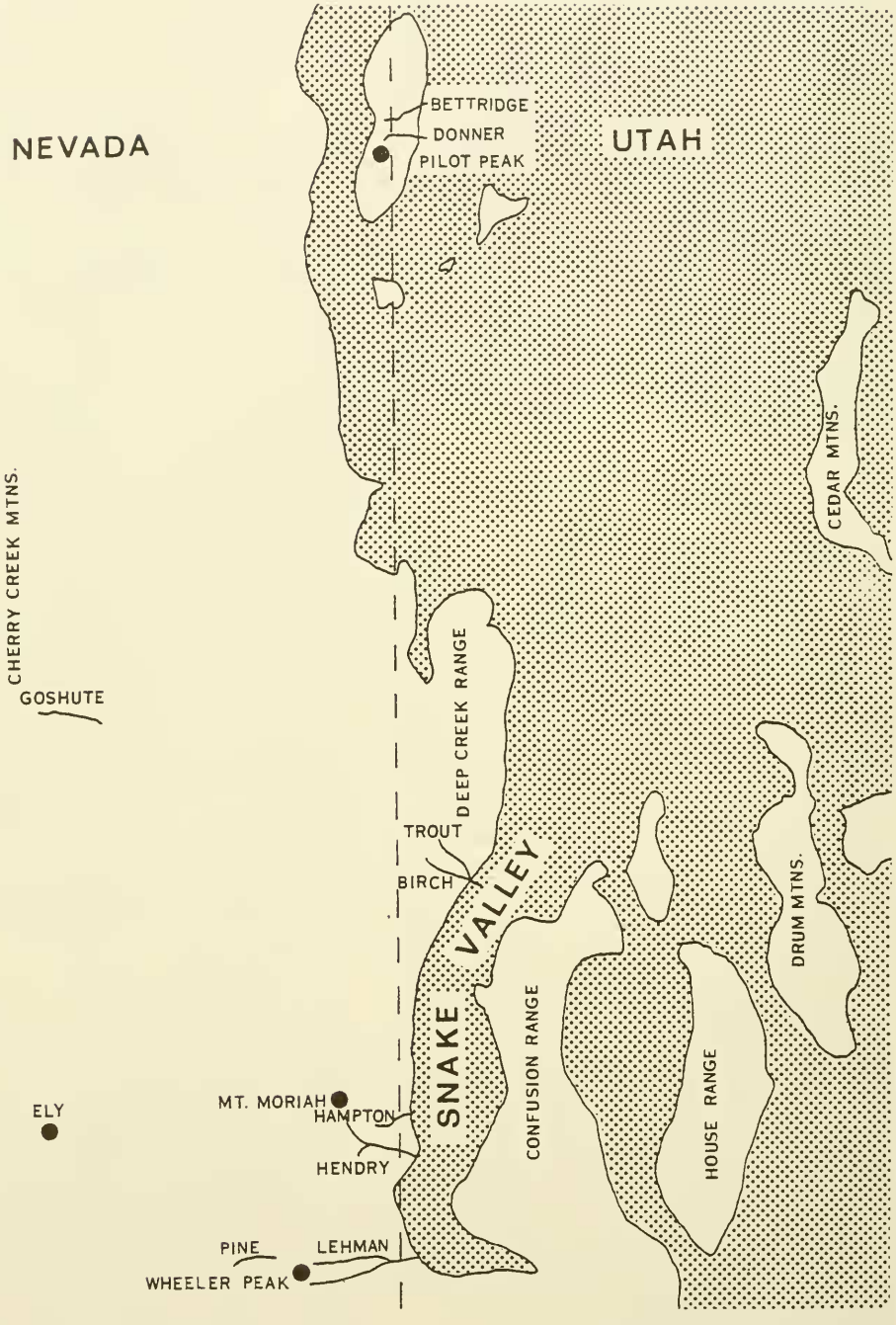

Fig 2. Local area map showing extent of Lake Bonneville (shaded) in relation to perennial streams having cutthroat trout.

greatly magnified when considered collectively. Many of the streams in the Snake Valley region have been affected by all these major impacts at some time during the recent past history of the area.

UNIQUENESS OF SNAKE VALLEY CUTTHROAT TROUT

Ancient Lake Bonneville went through several periods of fluctuations in which water levels were closely associated with climatic conditions (Gilbert 1879). According to Broecker and Kaufman (1965), four low levels occurred between 8,000 and 22,000 years ago, including one period of complete desiccation followed by refilling that took place about 11,000 years ago. This final desiccation of Lake Bonneville resulted in 10 or 12 independent basins being formed, one of which was the Snake Valley basin (Gilbert 1890). The northern portions of Snake Valley show a lake level elevation of about 5,100 feet. This would have prevented water from flowing out of Snake Valley and into the Great Salt Lake basin. In addition to such physical isolation, the cutthroat were forced to seek refuge in the streams to overcome the increased saline conditions brought on by the desiccation (Hunt et al. 1953). Thus, many populations of cutthroat in the Bonneville Basin have been isolated from contact with each other for about 8,000 years.

Wydoski et al. (1976) studied the electrophoretic patterns of proteins in cutthroat located in the Bonneville Basin, as well as several other groups of cutthroat and rainbow trout. No protein was unique or distinctive for S.c. *utah* specimens, but an unusual variation for muscle lactate dehydrogenase (LDH) was found in cutthroat from Trout and Goshute creeks, indicating a common ancestor. This unusually complex variation seems to indicate the presence of a variant allele. A unique evolutionary event, or series of events, occurred in the Snake Valley cutthroat trout LDH, which would indicate long-term isolation from the rest of the Bonneville Basin cutthroat trout.

Comparison of samples of the least chub, *Iotichthys phlegethontis,* in the western Bonneville Basin adds credence to the assumption of incipient speciation in fishes isolated in Snake Valley. Samples from Donner Springs (Pilot Peak area) have the typical fin ray counts given by Sigler and Miller (1963). Those found in Snake Valley have one less ray in the dorsal (7), anal (6), and pelvic (7) fins.

Smith (1966) stated that the mountain suckers (*Catostomus platyrhynchus*), of Deep Creek in the Deep Creek Mountain area are different from the typical northern Bonneville form.

The Snake Valley cutthroat trout differs from other cutthroat trout of the Bonneville Basin by having more basibranchial teeth and gillrakers and fewer scales in the lateral line series. The spotting pattern is more uniformly distributed over the body and not so concentrated posteriorly as in other Bonneville Basin cutthroat. The head appears longer and deeper with the body being more compressed and the caudal peduncle deeper, all of which gives it a more chunky body appearance (Behnke 1976 a, b).

STATUS OF THE SNAKE VALLEY CUTTHROAT TROUT

Pure populations are found in Pine, Goshute, Hampton, and Hendrys creeks, Nevada, and in Trout Creek, Utah (Fig. 2). Hybridized populations are found in Muncy and Mill creeks, Nevada, and Birch and Johnson creeks, Utah (Behnke 1976a, Hickman 1977).

Goshute Creek probably has the highest number of Snake Valley cutthroat, having about 1,500 in four miles of stream (McLelland 1975). The Nevada BLM and Nevada Fish and Game Department (NFG) have been instrumental in protecting and enhancing the habitat in Goshute Creek. During the 1977 drought Goshute Creek lost about 38 percent of the cutthroat population per mile. Because of these conditions a concerned NFG took 71 cutthroat from Goshute Creek and transplanted them proportionately into Water Canyon Creek (four stream miles habitat) and Clear Creek (one stream mile habitat).

Pine Creek, a very small stream with little habitat, has about 100 cutthroats (ex-

cluding fry), as does Hampton Creek, which is also a small stream (McLelland 1975). Pine Creek suffered some mortality as a result of the 1977 drought. Mile Creek, another creek with transplanted cutthroat, lost its entire population as the creek dried up from the drought.

Hendrys Creek had about 200 cutthroat in the headwater area in 1973. In 1974 eradication of rainbow trout below the barrier was conducted on Hendrys Creek to aid the fish's survival. Hendrys, Goshute, and Pine creeks are now closed to angling use. Goshute and Hampton creeks have past histories of losing all their fish from flash floods, and this is the reason they were barren in 1953 and 1960. Because of its small size, Pine Creek is also vulnerable to flash flooding. Therefore, the potential exists that the cutthroat populations in these streams could be lost in the future. During the 1977 drought NFG estimates that 50 percent of the cutthroat populations in Hendrys and Hampton creeks were lost because of dry stream sections. In the interest of managing these unique fish, NFG has identified about 25 streams suitable for reintroductions. They plan to rehabilitate about two to four streams per year in this effort.

During 1977 one of the most significant events to take place in the basin for the protection of desert fishes and the environment occurred in the Deep Creek Mountains, when the BLM filed for an emergency withdrawal of a 27,000-acre area of critical environmental concern within the mountain range. Increased uranium mining activity threatened to destroy many of the unique resources of the mountain area. A significant factor in justifying this action was the presence of the rare Snake Valley cutthroat in only about 1¼ miles of critical habitat on Trout Creek, as well as the presence of the rare giant stonefly (*Pteronarcys princeps*). The area was withdrawn from mineral entry on 3 May 1977 by the Secretary of the Interior under section 204(e) of the Federal Land Policy and Management Act of 1976 (PL 94-579). This withdrawal stays in effect for a three-year period and allows time for study of all resources to ascertain their values.

In September 1977, the BLM (Utah) funded a contract to the Utah Division of Wildlife Resources to provide for an inventory of all fish and wildlife resources on the mountain range. The contract will last until April 1979 and will provide BLM with inventory data necessary to evaluate the future withdrawal status. It is hoped the contract will define possible other streams inhabited by the cutthroat on the mountain.

In late October 1977, the Utah Division of Wildlife Resources (DWR) eradicated the rainbow trout below the natural falls barrier on Trout Creek as a start to implement management plans designed to expand the cutthroat population. Future plans call for the transportation of cutthroat from Trout Creek into the headwaters of Red Cedar Creek, a remote stream on the mountain which was given first priority for transplant efforts. The DWR plans to rehabilitate about seven additional east slope streams to enhance cutthroat survival back into their historic range. A habitat management plan (HMP) being developed for the entire mountain ecosystem by the BLM, in cooperation with the Utah Division of Wildlife Resources, will specify management of all east slope streams for the cutthroat. The complete HMP is scheduled for completion in 1978-79 for all the mountain resources, of which the cutthroat is an integral part. At present the BLM has developed an HMP for Trout Creek, having begun implementation of this plan in 1977 via Sikes Act (P.L. 93-452) authorities. Using Youth Conservation Corps (YCC) workers, some 75 long-type stream improvement structures were constructed in July in Trout Creek to aid the bank stabilization and pool quality enhancement for the cutthroat. Stream improvement work is scheduled again in 1978 by BLM using the YCC.

Although there are differences in the taxonomic characters between S. *c. utah* and the cutthroat found in Snake Valley, there also exists much overlap. Basibranchial teeth counts, which seem to be a distinctive characteristic separating the two forms, were found to be similar in number in one S. *c. utah* sample from Willow Creek, Jordan River drainage, Utah (Hickman 1977). With

the analysis of more samples from the Bonneville Basin, the degree of overlap between these cutthroat becomes more obvious. This overlap is further substantiated through the use of a computer-aided discriminant function analysis, which evaluates the similarities and differences between samples (Hickman 1977). Sixteen (16) morphomeristic character measurements (Table 1) from samples of various described and undescribed subspecies of cutthroat trout, and one sample of rainbow trout, were compared (Fig. 2). The closer the group centroid (represented by dot in Fig. 3), the more similar the samples. The cutthroat trout in Snake Valley and *S. c. utah* are closely situated, indicating a high degree of similarity. Of interest is the similarity depicted in the discriminate function plot between *S. c. pleuriticus* (Colorado River Cutthroat) and *S. c. stomias* (Greenback cutthroat). This supports the taxonomic evaluations of Behnke and Zarn (1976) that *S. c. pleuriticus* gave rise to *S. c. stomias* via an ancient headwater transfer, and that there exists little taxonomic difference between the two subspecies.

To avoid taxonomic confusion, which has led to subspecies classification delays, the cutthroat trout in Snake Valley should be considered a unique form of *S. c. utah*. *Salmo c. utah* is not abundant in any portion of its native range, and at one point it was thought to be extinct as a pure form (Miller 1950, Cope 1955, Platts 1957, Sigler and Miller 1963). The 1973 version of the U.S. Department of Interior's "Red Book" of endangered and threatened species listed *S. c. utah* as "status undetermined"; the International Union for the Conservation of Nature (1969) listed it as rare; Holden et al. (1974) considered it endangered; the Wyoming Game and Fish Department lists it as rare; the Nevada Fish and Game Department considers it endangered; and Behnke (1973, 1976b) considers it to be rare with a highly restricted distribution.

TABLE 1. Morphomeristic characters used in the discriminant function analysis, 1977.

Head length	Gillrakers lower
Upper jaw length	Gillrakers total
Snout tip to dorsal fin origin	Branchiostegal rays right
	Branchiostegal rays left
Dorsal fin length	Scales above latera line
Caudal peduncle depth	Pelvic fin rays
Caudal peduncle length	Pyloric caeca
Gillrakers upper	Basibranchial teet

CUTTHROAT DISCOVERY IN THE PILOT PEAK RANGE

In an effort to locate additional populations of Bonneville Basin cutthroat trout, a survey of the Pilot Peak Range (North of Wendover on the Utah-Nevada border) was conducted in 1977 by the BLM and Colorado State University (under a contract funded by BLM).

As a result of these surveys, only two streams were found containing sufficient annual flows to support trout populations. One stream, to the north of Pilot Peak, Bettridge Creek, has an abundant population of rainbow trout which were first stocked by the Utah Division of Wildlife Resources in the 1940s or early 1950s. The other stream, located in the adjacent canyon to the south of Bettridge Creek, is unnamed (for the present we have called it Donner Creek because it historically drained into Donner Springs). The city of Wendover, Utah, obtains a portion of its water supply from this creek.

Mr. Kent Sumners, Utah Division of Wildlife Resources, discovered the cutthroat in Donner Creek in April 1977 while sampling the stream at the request of the BLM. Subsequent specimen collection by the authors and their later analysis at Colorado State University confirmed this classification. Taxonomic analysis of the 17 trout sampled from Donner Creek proved most interesting. They are pure strain cutthroat trout (no sign of hybridization) and have a higher gillraker count than any other cutthroat population (24–29, avg. 26.1).

The origin of this cutthroat is uncertain; however, Howard Gibson, retired water master for the city of Wendover, indicated that the cutthroat were in Donner Creek when he commenced work on the stream in 1952 (pers. comm. with H. Gibson, Wendover, Utah). None of the other local residents

contacted could provide any information pertaining to the cutthroat, and most were unaware of its existence in Donner Creek. The Nevada Fish and Game Department has no record of cutthroat stockings in the Pilot Peak Range (letter to Don Duff, BLM, SLC from Pat Coffin, Nevada Fish and Game Dept., Elko, October 1977). The only cutthroat exhibiting such high gillraker numbers is the Lahontan cutthroat trout (*S. c. henshawi*) (Behnke and Zarn 1976). The most probable origin of the Donner Creek cutthroat is Pyramid Lake, because, from the late 1890s to 1930, cutthroat trout from Pyramid Lake were stocked extensively in Nevada. In 1910 Elko County received a large shipment of eggs, but no records exist on where these fish were stocked. Little stocking of Lahontan cutthroat occurred from 1931–1942, but in 1950 Lahontan trout from Summit Lake, Nevada, were used for stocking. After 1930 *S. c. henshawi* was considered rare, and it seems unlikely that a creek in the Pilot Range would be stocked with this cutthroat subspecies.

The discriminant function analysis (Table 1, Fig. 3) indicates that the cutthroat from Donner Creek are the most similar to *S. c. henshawi*.

SUMMARY

The Snake Valley cutthroat, a form of *S. c. utah*, is a unique desert fish resource located in the western Bonneville Basin which is worthy of protection and management for the scientific community as well as the American public. *S. c. utah* has promising possibilities for enhancing the basin states' fishery programs for wild trout manage-

Fig. 3. Discriminant function plot analysis chart showing relationship to cutthroat subspecies based on morphomeristic characters.

ment. The 1975 listing of endangered and threatened fishes of the western U.S. developed by the Desert Fishes Council did not consider this subspecies in its listing of sensitive western fishes. It is hoped that recognition of this subspecies for management concern will serve as an aid to organizations and agencies responsible for the management of habitat and this subspecies in the future. The ultimate management design for this subspecies and all others so recognized is to provide management to a degree whereby survival and protection of the species and its habitat are assured, so official status classification by the U.S. Fish and Wildlife Service is not necessary. However, should environmental conditions continue to deteriorate and this subspecies eventually become listed by the U.S. Fish and Wildlife Service, then a classification of "threatened" would provide the necessary protective status while still allowing for state-federal recovery programs to function.

The interest in desert fishes management has intensified by agencies and the scientific community by the discovery in 1977 of S. *c. henshawi* in Donner Creek of the Pilot Peak Mountain Range. The major significance of this find of S. *c. henshawi* is that it very likely represents the original Pyramid Lake genotype—the largest trout native to western North America and long believed to be extinct (Trojnar and Behnke 1975, Behnke and Zarn 1976). This find is worthy of intense management effort by the Utah Division of Wildlife Resources (DWR) and the BLM because the existence of this pure strain fish is extremely limited, as indicated by its official threatened status by the U.S. Fish and Wildlife Service. Colorado State University is continuing contract studies on this mountain range for the BLM. The BLM in Utah plans to implement the Pilot Peak Mountains HMP in 1978 under Sikes Act authorities in cooperation with the DWR. Stream habitat improvements are being planned for Bettridge Creek, which at present has a natural reproducing population of rainbow trout. This creek could serve in the future as a possible transplant site for the Lahontan cutthroat in Donner Creek. Both creeks have good stream habitat, being in a relatively undisturbed state from man and livestock activities and located in a remote area adjacent to the arid wastes of the Great Salt Lake desert salt flats.

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